THE OPERATIVE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR IN ADULTS.

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In the treatment of fractures of the neck of the femur, operative intervention is indicated when conservative treatment has resulted in non-union or when the break is of such a character as to render this result highly probable. These indications do not apply when the general condition of the patient, either as the result of infirmities or age, is such as to influence unfavorably the prognosis. Non-union, without pain or without marked functional disability,—*i.e.,* firm connective-tissue union,—without severe symptoms, is not an indication for operation. There are rare instances when other operative indications obtain. Gérard reports intra-articular suppuration, secondary to a bed-sore, developing in the course of the treatment of a break of the neck of the femur and Moore has reported a case of compound fracture of the neck of the femur.

It is absolutely essential, for the purpose of deciding definitely upon the method of treatment, to know the line of fracture as far as is possible. For this reason a good radiograph is a *sine qua non.* In an older person no impacted fracture is immediately operable. This type of break becomes operable when the subsequent developments prove that the impaction present did not influence the process of repair sufficiently to obtain union.

An impacted break demands operation only when the patient is relatively young, and when at the same time the impaction is such as to greatly diminish the use of the leg, either as the result of pain or because of deformity. Impaction is either the result of the neck being driven into the head-fragment or because the base of the neck is driven into the trochanter. If the neck is driven into the head in such a manner as to result in marked displacement of the head-fragment, usually downward and backward, and should it on manipulation not be possible to separate the fragments for the purpose of re-approximation, then an open operation may eventually be indicated.

A simple osteotomy, or a wedge-shaped osteotomy, may allow correction of the deformity. Should it be found at the end of one year after injury that the head of the bone is immovably fixed in the acetabulum and that there is with union sufficient deformity to interfere seriously with function, then a subtrochanteric wedge can be removed. It is my opinion that this operative procedure should not be undertaken until sufficient time has elapsed to allow union to occur,—therefore not inside of one year after the injury,—the reason for this delay being that no theoretical considerations based upon the study of an X-ray plate can demonstrate beyond question what the final functional outcome will be in a given case even when the displacement seems such as to preclude the possibility of a good useful hip. Another objection to early operation is that it is not possible to separate the fragments without further damage to the circulation,—and therefore if we are not going to run the risk of favoring non-union because of additional interference with the circulation,—we must wait until the blood supply has completely readjusted itself after the injury. If, after proper delay, it be found that the head-fragment is so greatly changed in shape that correction is out of the question, then it may be excised as a last resort, provided of course that the symptoms present can be attributed to the conditions at the seat of fracture.

If the neck is driven into the trochanteric region, no open operation will be immediately necessary. When at the time of injury the adduction, rotation outward and upward displacement is sufficient to produce deformity which would subsequently endanger function, then the impaction can be broken up and the fragments readjusted by abduction. In old injuries where the neck is driven into the head, the operative indications are the same as in recent cases, but when the neck is driven into the trochanter in such a manner as to produce great functional interference, a wedge-shaped osteotomy (antero-superior of the neck or subtrochanteric) will be necessary.

In old people no impacted fracture, however bad the condition, demands operative interference and the abduction treatment with breaking up of the impaction emphasized by Whitman, should not be abused by application to these unsuitable cases of old age.

No non-impacted fracture in a healthy robust adult in middle life or younger is immediately operable, except in such rare cases where the head-fragment is completely turned around in the acetabulum so that the cartilage surface is in contact with the fracture surface of the shaft-fragment. When the break is close to the head the operative indications depend upon the health of the patient and upon the time which has elapsed since the injury. If the patient is robust and the break recent, an open operation is contraindicated. I do not even see any advantage in the use of Nicolaysen's method in these cases, and believe that in a fresh break the approximation produced by abduction and maintained with plaster is quite as efficient as the same treatment combined with the spike driven through the trochanter, besides having the additional advantage of avoiding infection along the track of the fixing metal. If after two and one half months it is apparent on examination that no attempt at union exists, an open operation is indicated. The data which form the basis of believing the absence of any attempt at union are: ability to push the trochanter upwards, and rotation of the trochanter in an arc smaller than on the other side. In a doubtful case two radiographs can be taken, one with the leg lying at ease and one with pressure upwards on the leg,—the difference will be apparent immediately. Crepitus is not often obtainable at this time, although a soft grating sensation may frequently be appreciated in cases where a neoarthrosis is forming. The head in such an instance (Fig. 1)—*i.e.,* break close to cartilage, and no attempt at union,—should be excised. Excision is to be preferred because the circulation has been demonstrated to be insufficient to favor union even after adequate approximation and fixation.

This decision can be reversed only in cases where interposition of tissue found at the time of operation is evidently to blame for non-union and when it is found that the circulation of the head-fragment is good.

To decide whether there is sufficient supply of blood or not it is essential to have the wound absolutely dry so that no oozing will trickle into the fracture-cavity. The fracture cleft is packed tightly with gauze which is allowed to remain for a few moments; on removal of the gauze the fracture surfaces will be examined. In most instances where the circulation is insufficient, the entire fracture-surface of the head-fragment will appear yellowish-white with areas which are smooth and glisten showing where the shaft-fragment rubbed. About the edges wherever a little synovial membrane is still attached, there will be seen irregular bluish patches indicating some slight blood supply (Fig. 2). The ischæmic central area, when curetted, does not ooze—the bone seems dry and friable. The marked difference on the shaft-fragment is most striking. Portions of this will be covered with new connective tissue and if the bone is curetted, the surface oozes freely. The general appearance after removal of connective tissue is that of cancellous bone with abundant circulation.

If the patient be aged but still in good general health, the head fragment should be excised within a few days after the injury (Fig. 3).

The patient cannot afford to stay in bed for the time necessary to permit of union with a break close to the cartilage and then have non-union as the result of the treatment. A stiffly ankylosed but useful hip without pain is preferable. After months of treatment,—and prolonged pain connected with early attempts to walk, the general condition is so run down that an open operation with subsequent bed-treatment is out of the question.

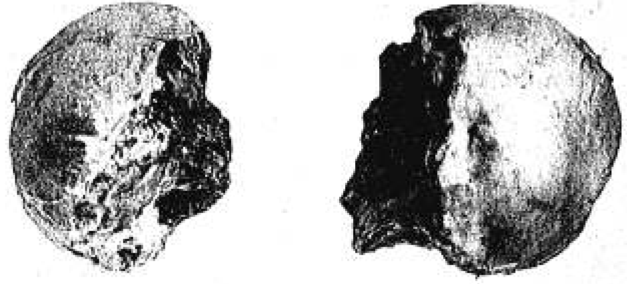


Fig. 1.

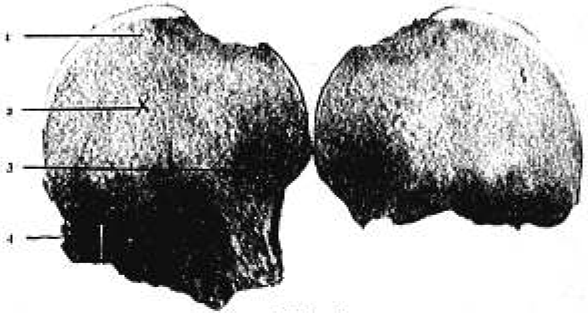


Fig. 2.

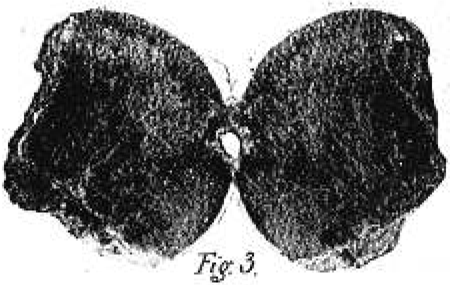


Fig. 3.

Fig. 1.—(*a*) Break close to cartilage. Specimen removed one week after injury. No impaction. Woman 65 years of age. (*b*) Break oblique close to head. Specimen removed three months after injury. No union. No circulation. Man 30 years old.

Fig. 2.—Shows Fig. 1 (*b*) cut. 1. Slight circulation in region of ligamentum teres. 2. Centre of head yellow, fatty, degenerated. No circulation. 3. Area of circulation close to attachment of synovial membrane. 4. Blood-stain from operation.

Fig. 3.—Shows Fig. 1 (*a*) cut. Mottled appearance due to areas of blood containing cancellous tissue. Fracture surface, did not ooze.

FIG. 4.

Fracture of neck of femur. Break apparently well out toward trochanter specimen. Fig. 1 (*a*) illustrates deception of radiograph.

When the break is of the middle of the neck and the patient is robust, there is a chance that non-operative care will result in union. It is extremely difficult even from a radiograph to state the exact course of breaks in this region. The radiograph may appear to show the break farther out as a whole than most of the fracture really is (Fig. 6), as is shown in the accompanying illustrations both of which are from the same case (Fig. 1, *a* and Fig. 4).

If at the end of two and a half months, it is evident that union is not likely to occur, an open operation is indicated. Whoever is in the habit of testing can easily detect the signs above referred to which mean absence of any valuable attempt at union.

The operation indicated, provided the circulation allows, is to fasten the two fragments together by means of a bone peg. In as much as the patient is presumably in good condition, this more accurate means of obtaining approximation and refreshing of surfaces is to be preferred to Nicolaysen's method of nailing which is less accurate and does not permit of refreshing the fracture surfaces. The disadvantage of using a metal peg is that it always becomes loose and in the majority of instances has to be removed. The metal does not serve its fixing purpose any longer than the bone peg, which is finally absorbed.

Frangenheim has demonstrated that ossification of the connective-tissue union is not liable to occur much inside of one year. It is therefore evident that if we are to run no risk, weight must not be borne on this thigh inside of one year although it would seem reasonable, that assuming the upright position with the corresponding physiological strain, would tend to favor the deposition of bone in such a manner as to restore the weight bearing trabeculæ. The early months may be passed in plaster, the later ones with a metal hip-splint.

After an operation no test but use will disclose the condition at the seat of fracture. We are sure of approximation and fixation and know that no intervening tissue prevents union and therefore it is best to delay this test of use until time has given the connective-tissue union opportunity to ossify.

In non-operated cases which are going to unite the connective-tissue union is so firm that it is impossible to detect an abnormal joint. In fact this connective-tissue union may be so short and solid that on resuming use of the leg it may be some weeks or months before the connective tissue stretches sufficiently to give symptoms proving that the assumption of bony union was erroneous.

It is my opinion that some cases which would have ossified eventually do not do so because the patients are allowed to walk and bear weight too soon. The irksome trial of waiting with an apparently good union is hard to bear. Even in cases where connective-tissue union is to be the outcome, it is far better to wait until this connective tissue is firm than to run the risk of stretching by too early straining of the new tissue. After the patient has been permitted to walk even in cases where abundant time has been allowed for union, it may become apparent within a few weeks or months that an abnormal joint exists associated with such disability and pain as to render excision of the head imperative. It is apparent then that a robust individual is obliged to sacrifice one year for the chance of saving the head-fragment in cases where the break is distinctly in the middle of the neck and it is therefore equally apparent that the operation of pegging should not be recommended unless the conditions are such as to render it highly probable that the outcome will be favorable. It must be borne in mind that even in non-operated cases it may not be possible to detect neoarthrosis until the patient walks with full weight; but in most instances two and a half months will be sufficient to make sure of the condition.

At the time of operation, *i.e.*, two and a half months after the injury, there may be found present in the neck, conditions which preclude a fixing operation. The crushing of the neck may have been so extensive or the break may have been so irregular that no approximation favorable to subsequent union is possible. In such an instance the head-fragment will be excised immediately.

Again there may be found in the neck-fragment, cystic spaces chiefly toward the anterior surface. These may be small or occupy almost the entire diameter of the neck. These spaces may form recesses connecting with the general fracture-cavity, or they may be entirely separate, and broken into when curetting the surface for the purpose of examining the circulation of the fragment. The contents is like the usual fracture-fluid in an old fracture-cavity; it is reddish-brown, slightly cloudy, without any evidence of blood-clot. The walls of the cysts, which have come under my observation, in three cases, were not covered with connective tissue,—simply bare cancellous bone. The spaces are probably due to modifications of the cellular elements of the cancellous bone secondary to impaired nutrition, which in turn is due to interference with the circulation. They correspond possibly to similar cyst forming degenerative changes observed elsewhere in the connective tissues of the body. In the instance of a woman about forty, there was one cyst about one inch in diameter near the anterior wall of the neck. The break was about six months old. In another case, a man of fifty-eight years, there were several small cysts. This break was of fourteen months' duration. In another case, a man thirty years of age, there was one large cavity which communicated with the fracture-cavity. This break was of about four and one half months' duration. The first two were transverse breaks in the middle of the neck; the latter was oblique, close to the cartilage line. The spaces contained no dead bone. These cysts when large, preclude approximation and unless the circulation of the remaining portion of the neck is very good, the head had better be excised. In an aged person with a break of the middle portion of the neck, no open operation for the purpose of approximation and fixation is ever indicated. The outcome of such operations at my hands has not been favorable. These people have not time or vitality which enables them to spend one year with a doubtful outcome at the end of this time.

Nicolaysen's operation has been recommended for these old people, for instance, by Cobb. As already stated, it is my opinion that abduction with plaster fixation is to be preferred, and should subsequent examination reveal a neoarthrosis, or non-union, it is better to excise the head, provided the patient's general condition permits.

If the injury be old when first seen, the only treatment in cases of non-union, is to excise the head whether the patient be aged or young.

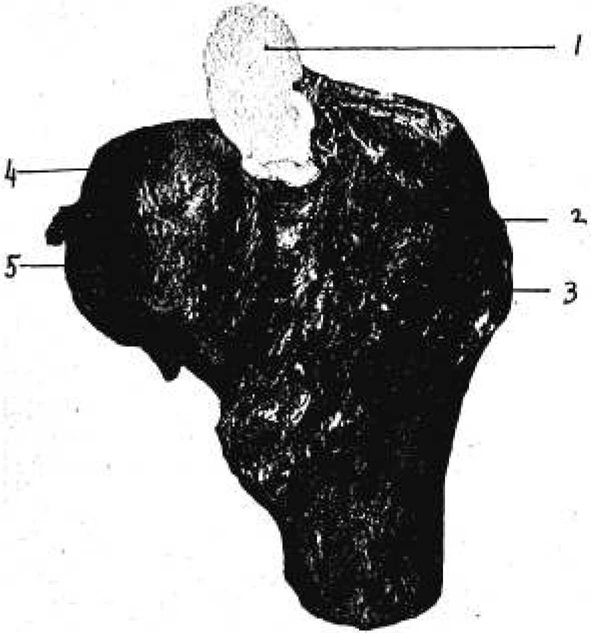
If a neoarthrosis has existed, even a few months without proper fixation, there is upward displacement, rotation outward and adduction. Even though traction is applied for some time, it is usually not possible to restore the normal position of the fragments. The neck of the femur gradually becomes absorbed,—both the piece connected with the head and the fragment attached to the shaft. This absorption continues until the trochanter base of the neck comes in contact with the brim of the acetabulum, hence the protected head remains intact (Fig. 5).

Even when absorption of the neck is not complete, any operative method aiming at approximation and fixation is not feasible for the following reasons: The head itself has become fixed in the acetabulum; there is connective-tissue union between the central portion of the acetabulum and the head itself. The cartilage in this region is destroyed. Where cartilage is opposed to cartilage, however, there is no destruction and no adhesion unless there has been an injury of this particular region (Fig. 6). The absorption of the neck progresses in a plane which corresponds to the rotated outward, abducted and upward displaced shaft. Should it be possible to restore the fragments to their normal level, it will be found that after placing the shaft-fragment in its physiological position,—therefore after correcting the adduction, abduction and upward displacement,—that there is a gap between the fracture surfaces. This gap is widest below and behind. Only the upper and anterior portion of the neck will be in contact. In cases which have existed a long time, it is

Fig. 5.

Fracture of neck of femur. Woman 55 years of age. Break 3½ years; Almost complete absorption of neck. Marked pain. Treatment: Excision of head; fixation of shaft to pelvis.

Fig. 6.



Fracture of neck of femur. Break middle of neck. Young man. False joint. Fibrous union. Specimen obtained after death several years later. (Case of Dr. Marvel, Long Branch, N. J.)

1. Gauze in abnormal joint. 2. Fibrous union; surrounding neck and forming capsule for new joint. 3. Edge of normal capsule (cut away). 4. Cartilage destroyed opposite centre of acetabulum. 5. Normal cartilage opposed to cotyloid cartilage of acetabulum.

not possible on manipulation to overcome the adduction enough to restore the shaft even to the normal straight position without division of the adductors. These conditions prevent approximation and fixation in the normal straight position, to say nothing of a slightly abducted position which would be preferable.

It is therefore best to excise the head. This applies to old fractures in the young as well as in the aged. Six months of non-union will show the effects of absorption and one year will make changes enough to preclude any fixing operation. In most instances the neck will be completely absorbed at the end of two and a half years (Fig. 5). It is therefore apparent that as a rule no matter what the age of the patient, excision will be resorted to in cases of non-union which have existed for one year. To fix the two fragments with the thigh adducted and rotated outward so as to obtain approximation is to court failure because of the subsequent functional disability due to malposition. Even if union did occur a secondary subtrochanteric osteotomy would be necessary to relieve the deformity.

Whenever non-union occurs with a break at the base of the neck, a very rare complication of this accident, the same indications apply as with breaks in the middle of the neck. The decision will be modified more often in favor of saving the head-fragment because of the better conditions of the circulation in the neck-fragment. Base fractures have a tendency, particularly when the trochanter itself is injured, to throw out a great quantity of callus and to form osteophytes which may obstruct union. This callus formation has given rise to operative interference, but personally I have had no experience with a case in which it seemed to be wise to interfere with the callus because of the limitation of motion.

Operation for Exposing Seat of Fracture.—The exposure which seems to me most desirable is obtained in the following manner:

The skin incision carried to fascia, extends from about 1½ inches behind the anterior superior spine on the crest of the ilium downwards and backwards to the posterior margin of the trochanter, and then vertically down the thigh about 5 inches (Figs. 7 and 8). The skin behind with fat is now

FIG. 7.

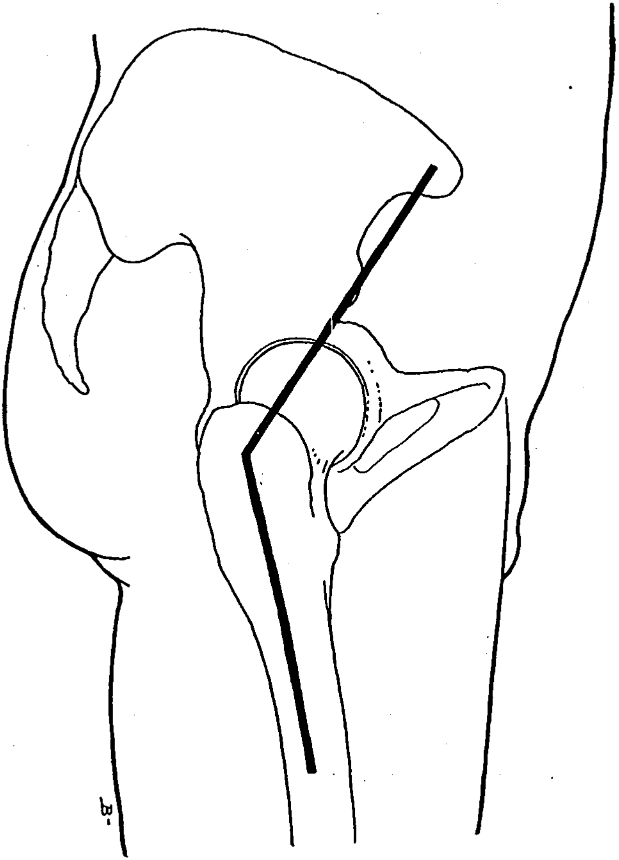
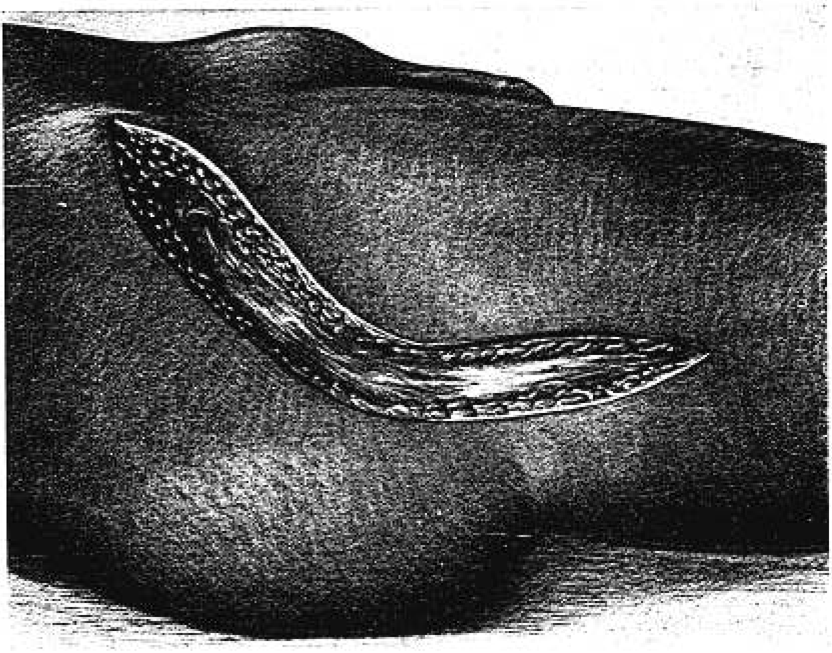


Diagram showing relation of line of incision to bony landmarks.

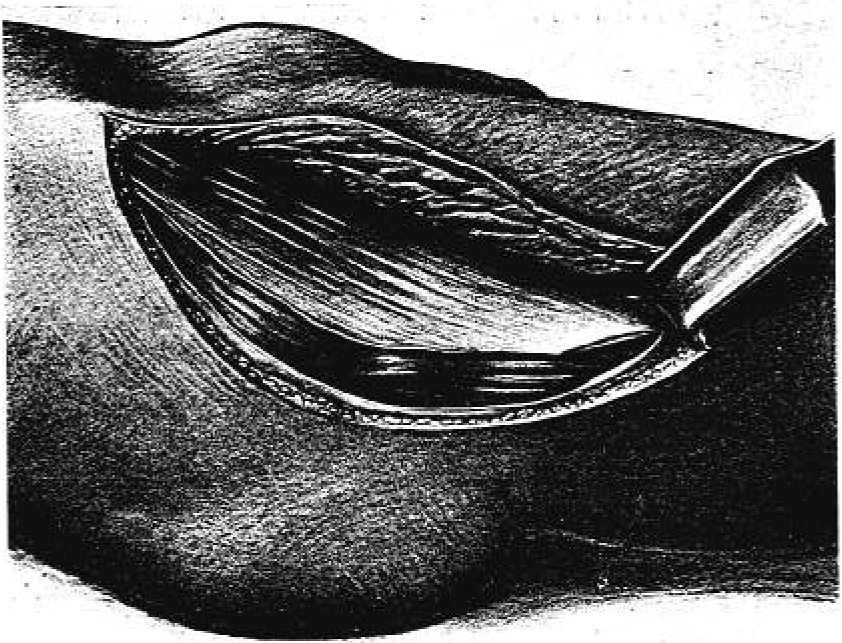
separated from the fascia overlying the tensor vaginæ femoris, leaving the anterior skin-flap in place. The fascia is divided along the posterior margin of the tensor vaginæ femoris from

Fig. 8.



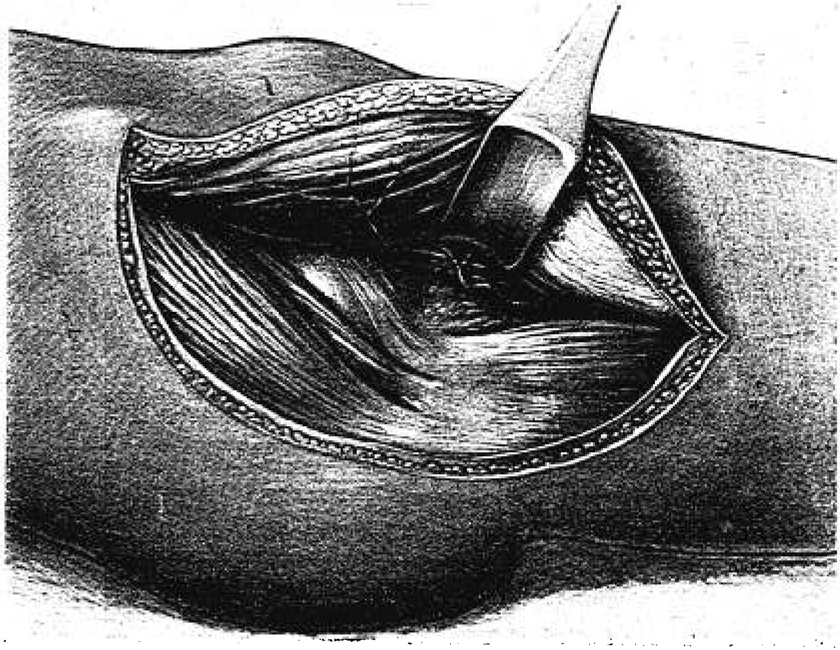
Skin incision.

FIG. 9.



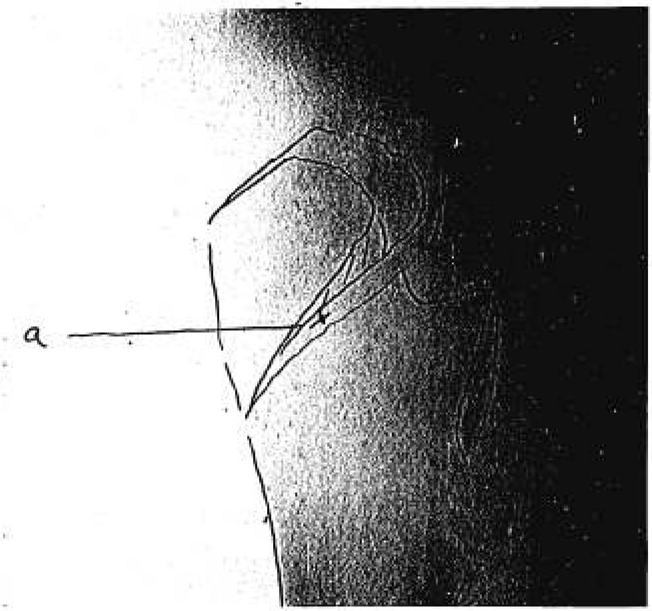
Division of fascia and tendon of tensor vaginæ femoris.

FIG. 10.



Tensor vaginæ femoris pulled inward, exposes triangle from which fat pad has been removed. Internal boundary: rectus femoris. Superior boundary: blended margin of gluteus medius and minimus. Inferior boundary: vastus externus. Floor: capsule of joint with "y" ligament. Anterior margin of greater trochanter crossed by external circumflex vessels.

FIG. 11.



Illustrative case. Excision of head. Remnant of neck in acetabulum; (*a*) osteotomy of trochanter; good functional result. No pain and ¾ in. shortening; slight motion at hip.

the crest of the ilium down to the tendon, and the tendon itself is divided from behind obliquely downwards and forwards (Fig. 9). This skin-subcutaneous fat fascia and muscle-flap is turned forwards, exposing a triangle bounded above by the fused margins of the gluteus medius and minimus, internally by the rectus femoris and inferiorly by the vastus externus. This triangle is filled with a fat-pad and is traversed in the lower part by branches of the external circumflex vessels. This fat-pad is excised in toto to expose the floor, which is formed largely by the anterior margin of the trochanter major, the capsule of the hip-joint; the antero-external brim of the acetabulum. The inner boundary of the floor is the external margin of the ileofemoral ligament. The digital fossa is exposed above, and along the margin of the acetabulum, the reflected head of the rectus femoris (Fig. 10).

By rotating the thigh slightly outwards, the exact seat of the break can be felt. The capsule is divided by an incision starting at the brim of the acetabulum close to the thick fibres of the "Y" ligament, and carried downwards close to this ligament until opposite the place where the external part of the capsule becomes attached to the neck; the incision is then carried upwards dividing the capsule on the neck close to the bone. When this triangular flap is retracted, the break is easily examined. Should it be found, on exposing the floor of this triangle, that the break is partly inside and partly outside of the capsule, great care should be taken not to divide the portion of the capsule attached to the head-fragment. Plenty of room can be obtained by dividing the portion attached to the shaft-fragment anteriorly and below.

By abducting and rotating outward, a very good view of the fracture is obtained. At this point the fracture-cavity should be carefully packed with gauze and the operation delayed for a few moments to allow checking of all oozing. On removal of the gauze the condition of the circulation in the head-fragment is observed, whether there are ischæmic areas or not; whether the bone oozes after slight curetting, or whether there are cysts or not.

In a case which has existed for some time a new connective-tissue capsule for the neoarthrosis will sometimes be found within the normal capsule and attached to the respective margins of the break (Fig. 6). At first sight this connective tissue will appear as a rather firm connective-tissue union, but if it be cut it will be found that the central portion, corresponding to the cancellous tissue of the neck, presents a cavity filled with a moderate amount of sticky reddish fluid and lined with granulations. In other instances the fracture-surfaces are worn smooth, the head-fragment in particular being devoid of granulations, whereas the shaft-fragment is covered with smooth connective tissue. This condition is found in older cases.

In very recent cases, the fracture-cavity is filled with the ordinary sanguineous fracture-fluid found about most fractures.

If the head-fragment is to be excised, the slight remaining attachments about the neck are divided as well as the connective-tissue union to the shaft-fragment when present. A curved blunt instrument is now inserted between the head and the acetabulum, the head pried off and a stout knife curved on the flat introduced to divide the ligamentum teres. After this has been accomplished, the head-fragment is rotated within the capsule until the smooth articular surface faces outwards. Two blunt instruments are now passed into the acetabulum behind the fragment which is easily forced through the opening in the capsule. It is an advantage to have the smooth cartilage surface present in the capsule opening. This is not possible when there is much neck attached.

The older the injury, the greater the difficulty in removing the head because of the connective-tissue union to the acetabulum. After removal of the head-fragment, the cotyloid cartilage is removed with a large sharp spoon. A transverse osteotomy is done at the base of the trochanter from the digital fossa side. This enables the trochanter to be tipped outwards when the head is placed in the acetabulum. The osteotomy should be slightly oblique and outwards so that the trochanter may fit in the angle between the shaft and the pelvis. There may be quite an annoying hemorrhage at this point of the operation from the artery lying in the digital fossa.

The anterior inferior margin of the acetabulum should be cut away for the reason that if this projecting lip is left the shaft of the femur will be rotated outward after being placed in the cavity. The periosteum over the brim of the acetabulum, the outer side of the shaft of the femur and the inner side of the trochanter should be stripped up so as to permit of bony approximations.

After the shaft has been placed in the acetabulum, the trochanter is fastened to the pelvis by means of a stout bone peg, and this fixation reënforced by suturing the periosteum of pelvis and trochanter with chromic gut. The operation is in this respect the procedure recommended by Gangolphe (Fig. 11).

In recent cases these steps are exceedingly easy, whereas in older cases great difficulties are met because of the changes in muscles and ligaments. In an old case, it may be necessary after removal of the head to abduct the leg to about 90 degrees, if possible, engage the top of the femur in the cavity and gradually force the leg down. At times it may be necessary to resect the upper portion of the trochanter. If there is much tendency for the femur to leave the acetabulum, it is best to fix the femur to the pelvis by means of a bone peg of 25 F. calibre. The position of the femur should be about 30 degrees abduction with the patella pointing straight upward.

After suturing the capsule fascia and tensor vaginæ femoris tendon with interrupted catgut, the skin-wound is closed with a small rubber tissue drain in the lower angle.

From the time the shaft is placed in the acetabulum until the plaster dressing is hard, an assistant holds the leg in the desired position.

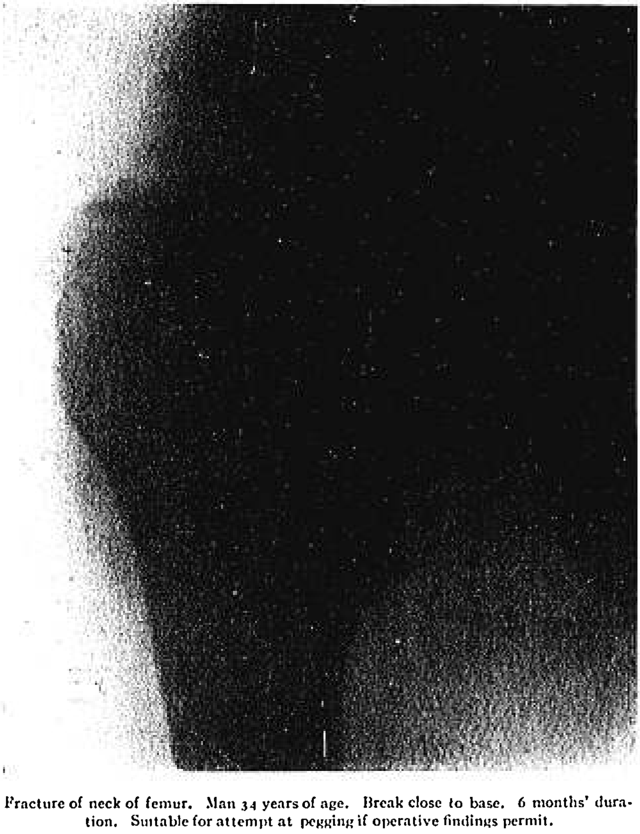
When on operation, examination reveals conditions which permit of an attempt to preserve the head-fragments, the fracture-surfaces are freshened with a curette (Fig. 12). After this, it must be ascertained that the head-fragment is movable at least enough to allow adjustment with the leg in a corrected position. After this readjusted position has been obtained, preferably with the leg abducted and rotated so that the patella faces straight upward, the neck is bored through the trochanter in the direction of the break, this being inwards, slightly upwards and slightly forwards. The upward and inward direction can be regulated according to the position of the neck but the forward angle must be estimated. One feels the drill pass the trochanter cortex; the next firmer resistance is met in the region of the break and finally the resistance at the cartilage is encountered. The distance in an adult man is about 4 inches and in a woman about 3½ inches (Fig. 13).

The bone peg best adapted is made of the shin-bone of an ox turned on a lathe or sawn out and filed practically round. It is not well to have the peg absolutely round and if turned on a lathe, it should be fluted. The engaging end should be slightly conical for the reason that after removal of the drill and introduction of the peg, some slight motion may take place between the fragments. A shoulder presents, and if the end of the peg exactly fits the opening it will not engage in the drill-hole of the neck-fragment. It is desirable to have the drill of irregular shape fluted because this irregularity enables the blood in the drill-opening to escape. If this opportunity is not afforded the incompressible blood is driven into and injures the cancellous tissue. For the purpose of sterilizing, the peg may be boiled on two consecutive days for about half an hour. I have used such pegs many times in different regions of the body, and have as yet seen no bad results except in the case of an os calcis where, owing to a fault of my own, the peg was not driven in sufficiently through the tendo Achillis and therefore rubbed on the boot.

A large bone peg absorbs in about ten months to one year.

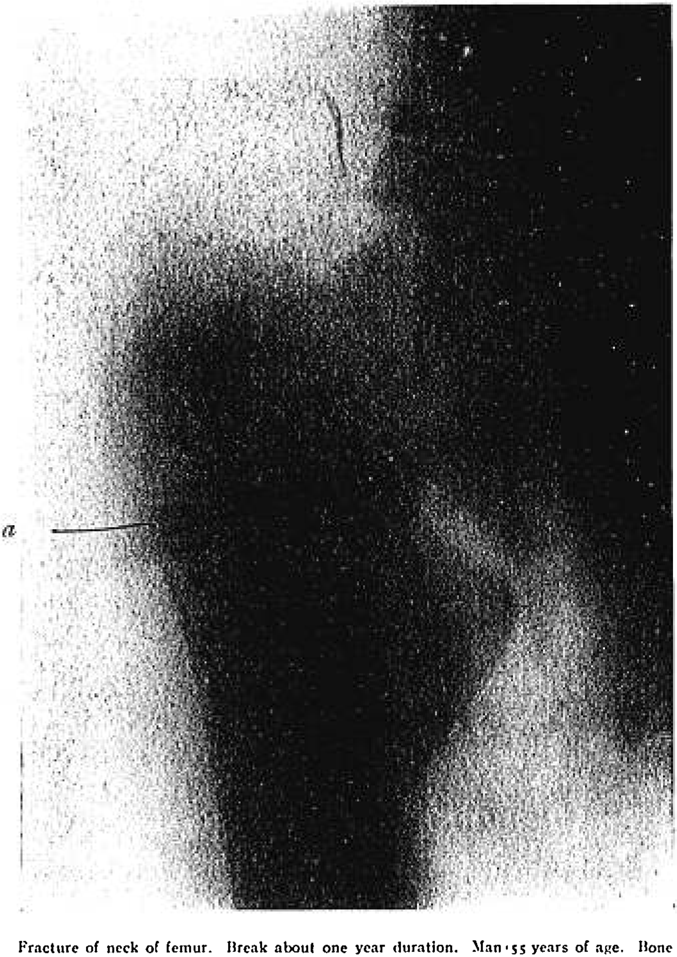
Other Methods of Exposure.—An incision is made downwards from the anterior superior spine. The fascia to the outer side of the sartorius is divided and by blunt dissection,

FIG. 12.



Fracture of neck of femur. Man 34 years of age. Break close to base. 6 months' duration. Suitable for attempt at pegging if operative findings permit.

FIG. 13.



Fracture of neck of femur. Break about one year duration. Man 55 years of age. Bone peg in situ. Border line case, because of changes in neck.

the tensor vaginæ femoris being pulled back, the region of the joint is reached (Hueter).

Another variety of the anterior exposure is to separate the muscles to the inner side of the sartorius, penetrating to the outer side of the rectus femoris. Both of these wounds are narrow and deep; the exposure for extensive work and examination is not good, retraction is difficult, and the field at the bottom of the wound is small.

The "U"-shaped lateral exposure, without division of the tronchanter, is insufficient for exposure. When the trochanter is divided (Gillette), the exposure is very good to be sure, in fact better than any other, but in my opinion the method is unnecessarily destructive and in the event of an excision not being necessary, demands the fixation of two fragments to the shaft.

In cases where an excision is to be considered *a priori,* the method is excellent, inasmuch as an osteotomy of the trochanter is essential to place the shaft in the acetabulum and frequently partial resection of the trochanter is imperative.

Kocher's posterior exposure through an angular incision is far too extensive an operation to be considered in connection with fracture work as Kocher has himself emphasized.

A "T"-shaped incision has been used by Painter. For most work the anterior angular incision above recommended will be sufficient and in cases where excision is contemplated *a priori,* Gillette's "U"-shaped incision with division of the trochanter.

For fixing purposes, wire, screws, nails and bone can be used. A bone peg, such as is recommended by Gillette and Peckham, has the advantage that it can be used of large calibre so that there is less tendency to cut the cancellous tissue because of the strain put upon it. Another advantage is that the material, although foreign, does not necessitate removal as frequently as metal pegs and finally the peg becomes absorbed in the course of time.

I have considered these advantages sufficient to warrant giving a bone peg preference and have therefore always used a freshly prepared peg. In other regions of the body, I have used ivory pegs but find that although satisfactory, they take longer to absorb. Wire has been used successfully by Koenig and Painter; screws by Trendelenburg, Freeman, Moore, *et al.*, and steel nails by many: Thompson, Painter, Cobb, Gelensky, Herz, Martens, *et al.*

Thompson recommends two nails side by side; Lund fixed the fragments by driving the nail through the head into the acetabulum.

Gangolphe endeavored to prevent the shaft from riding up by detaching the greater trochanter and fastening it to the upper margin of the acetabulum to deepen the socket as it were. (See above.)

Gelensky filled the gap between the two fragments with "ausgeglühter" bone and fixed the bones with Gussenbauer's clamp, which was removed on the 37th day. The pieces of bone were cast off.

After-Treatment.—Postoperative dressing. Whether the head of the bone has been resected or not, the first dressing should be a solid plaster cast extending from the toes to the nipple line with the leg in an abducted position. This position is always possible in resection cases but may not be in cases where a pegging operation has been performed.

This plaster must be so arranged that the wound can be dressed and at the same time the greatest strength must be on the outer side in the region of the hip and waist so that adduction cannot recur. Another essential point is to have the plaster so arranged that during the first weeks traction can be used.

It is therefore best to apply a solid spica from above the knee to the nipple line; over this is placed a strong moulded plaster external splint reaching from the axilla to the toes. This in turn is bound to the underlying plaster by strong muslin bandages. A window is cut in the underlying spica.

At the end of four weeks, the bandages should be removed from the peg below the knee and the knee flexed daily over the edge of the bed. At the end of eight weeks, a fresh firm spica is applied including the pelvis and thigh, the leg being still abducted.

From this time on it is permissible to allow the patient to use crutches although no weight is to be borne on the leg. When a pegging operation has been done, a Thomas hip-splint should be used from the eighth week on. This splint should be worn for one year—in other words, long enough to give the fracture time to ossify.

In excision cases, at least six months should be allowed to pass from the time of operation before the patient bears weight on the leg.

If, after a pegging operation, the patient is allowed to walk before sufficient time has elapsed to permit of bone being deposited in the newly formed connective tissue, it will be found that in the majority of instances, the patient will be comparatively comfortable at first but that within a few months, as the leg begins to be used more and more, pain reappears together with a varying increase in the amount of shortening with some adduction and rotation outward. The new connective-tissue union was short enough and strong enough to sustain the weight of the patient with comparative comfort for some time, but with increasing use this union stretched and a new neoarthrosis formed. The operation in this instance is not a success for in spite of the fact that for some time the condition is better than before operation, there is a gradual return of the pre-operative conditions. It is not safe to state inside of one year what the final outcome is to be.

Immediately after resuming use of the leg with or without excision of the head, the patient seems much improved for the reason that the adhesions secondary to the operation and the fixation have immobilized the bones sufficiently to prevent pain. It is the pain more than deformity or limp which incapacitates the patients. After a few months' time it will be evident whether or not the relief observed immediately after operation is due to conditions which are permanent.

When the operation with pegging is completely successful, the result is very good indeed. There is no pain, very slight shortening with objective limp, very little deformity and a perfectly useful leg.

When the pegging operation is less successful there may be union with marked shortening, some abduction and rotation outward, distinct functional deficiency, but still a leg which is serviceable with a cane and without marked pain.

In other cases fairly successful, the connective-tissue union is sufficiently firm and short to give fair functional result with not much pain; often some degree of motion which is probably at the seat of fracture. There is some adduction and rotation outward with shortening and limp. Either of these possibilities is a great improvement over the original condition, because of the absence of pain and better ability to get about.

When the operation is a failure, the condition of the hip gradually returns to what it was before operation and finally assumes the condition observed in non-united fractures of the neck of the femur which have not been operated. At first there is apparent improvement, less pain on motion, greater ability to move the leg, which is particularly emphasized in the ability to push the leg forward and lift the foot off the floor, while sitting in a chair. As time goes on and the strain put upon the leg increases, the symptoms of discomfort increase rather than diminish as in cases where the union, either fibrous or bony, obtained is sufficient to meet the requirements of use. This increase of symptoms is due to the gradual stretching of the supporting structures. The trochanter finally displaces upward on the outside of the ilium.

When the head has been excised, the result aimed at is to have the shaft-remnant of the neck or the upper end of the femur remain ankylosed by bony union in the acetabulum. If there remains some motion at the hip, as is occasionally the case, this fortunate event at the present state of our knowledge must be considered accidental and cannot be attributed to purposely prepared conditions at the time of operation. It would seem as if a long neck-fragment on the shaft protruding into the acetabulum favored this result. It is my opinion that methods of treatment favoring this result such as passive motion, should not be instituted in the hope of obtaining motion, until sufficient clinical evidence has accumulated to demonstrate the conditions which must be present to expect such an outcome and at the same time protect from displacement of the femur upwards.

The conservative aim must as yet consist in an endeavor to obtain firm ankylosis. Such an individual will have a useful leg, no pain, but some deformity with varying degrees of rotation outward and perhaps adduction. There will be some shortening and objective lameness, which, however, is largely offset in cases which have united with the leg abducted by compensatory tilting of the pelvis and lumbar curve of the spine and which may be relieved to some extent even in cases which have united with the leg straight or adducted by the use of a high sole.

The least desirable result is to have the femur escape from the acetabulum and displace upwards. There is shortening, lameness,—subjective and objective,—rotation outward and adduction. The pain, however, is not as great as a rule as in cases of non-union, where the head-fragment is still in place and corresponds more to the condition of patients who have had non-union for many years and whose tissues have finally become adapted to the abnormal state of affairs in such a way as to lessen the amount of discomfort. The only advantage may be in this instance that the period of extreme discomfort is shortened.

The majority of the patients having had an excision will derive benefit, whereas the outcome of a pegging operation is far more doubtful and should therefore be limited strictly to the very few cases, the characteristics of which have already been enumerated.